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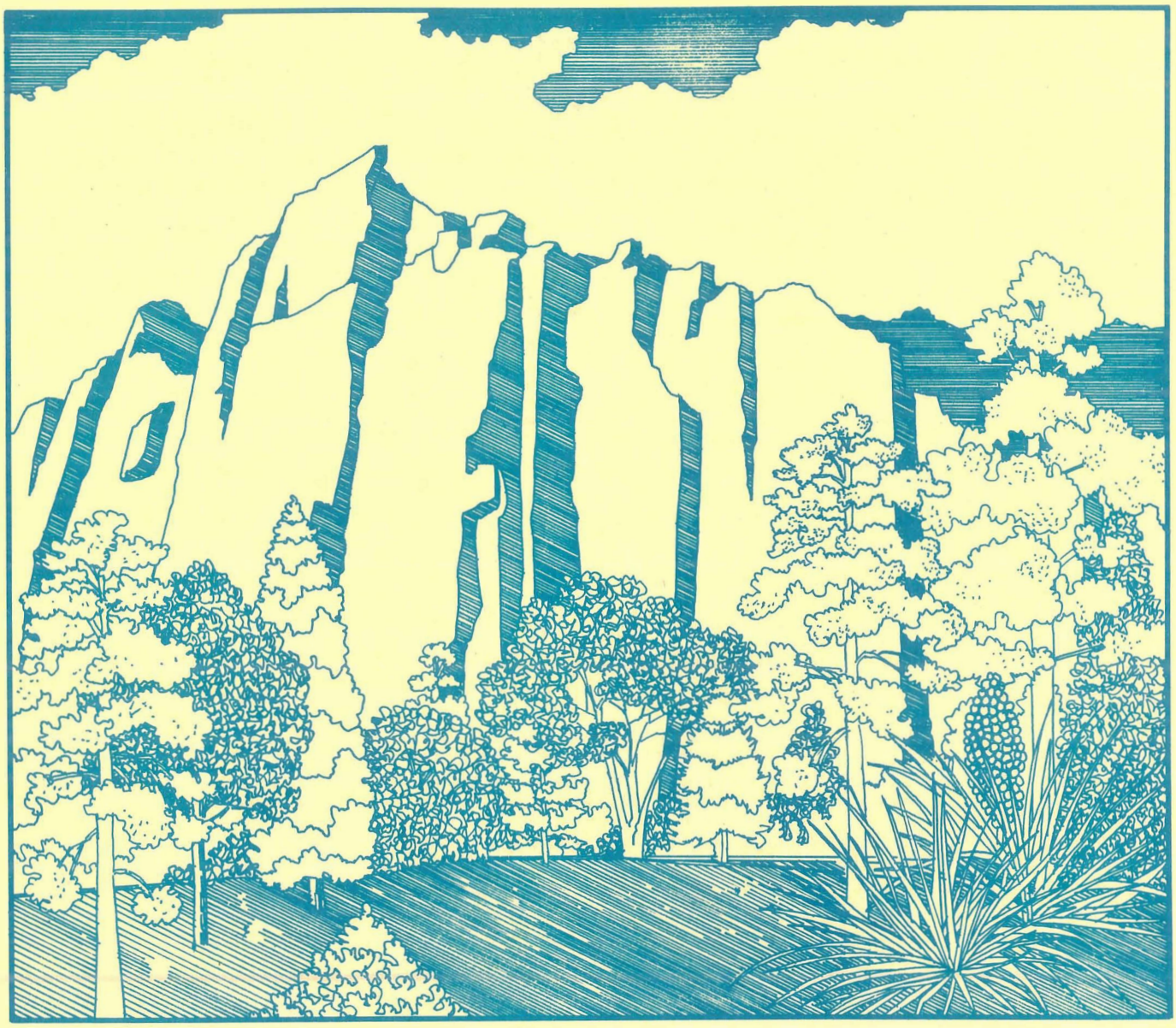
BIOLOGICAL EVALUATION
Rate of Decline of Rio Grande
Cottonwoods Subjected to Flood Plain
Aggradation and Other Environmental Stresses

Chaco Culture National Historical Park
New Mexico

December 1982



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USDA Forest Service, Southwestern Region
State and Private Forestry
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SUMMARY

Flood plain aggradation in Chaco Wash, Chaco Culture National Historical Park, has created an environment unfavorable for cottonwood root survival or growth and caused depletion of root starch reserves. The resultant slow decline of the trees was accelerated by freeze damage which occurred in late May 1980. Trees with moderate to severe dieback will die in the next few years. Except for a few scattered individuals, the stand will be dead by about A.D. 2000; it can only be maintained by artificial regeneration.

INTRODUCTION

At the request of Park Superintendent Walter Herriman, the Forest Pest Management (FPM) staff investigated ways of determining the rate of decline of Rio Grande cottonwoods (Populus wislizenii (S. Wats.) Sarg.)) in the wash at Chaco Culture National Historical Park, New Mexico. As a result, Rocky Mountain Forest and Range Experiment Station and Northeastern Forest and Range Experiment Station cooperated with FPM to provide the services of a plant pathologist experienced in evaluating dieback and decline in hardwoods, following defoliation by insects, which cause effects on trees similar to those found in Chaco Canyon. Cottonwood decline in Chaco Canyon has been previously described (Wood 1982). Accordingly, we visited Chaco Canyon between September 20 and 22, 1982, for the purpose of selecting representative trees, rating and photographing them, and determining the starch content of roots. Starch content of deciduous tree roots provides a measure of the severity of stress from defoliation and potential for survival following defoliation and dieback (Wargo 1978).

METHODS

Fourteen trees located in Chaco Wash near Pueblo del Arroyo and Hungo Pavi, which displayed various degrees of dieback and subsequent crown regrowth, were selected, rated, and photographed. All trees were marked with blue and white striped flagging bearing a location and tree number.

Using hand tools, we excavated around the base of each tree until one or more roots were located. A portion of root was excised and later cross sections of root bark and wood were cut with a microtome (> 75 thick), stained with I_2KI, and rated for starch content as depleted, low, moderate, or high (Wargo 1975). Normally the starch content of healthy deciduous trees entering a dormant period is high.

RESULTS AND DISCUSSION

The crown condition and starch content of the 14 trees selected are shown in table 1. Most of the trees with no or light dieback had high starch (one each had moderate and low ratings), those with moderate dieback had moderate starch, those with heavy dieback-good regrowth had moderate to low starch, while those with heavy dieback-poor regrowth had low to depleted starch.

The low or depleted starch reserves of trees with moderate and heavy dieback indicate that they have been severely stressed and will probably die or be reduced to a few sprouts on the main stem in 2 to 3 years. Even those trees that showed good resprouting have starch reserves that are lower than they should be at the end of the growing season. Also, dieback is continuing on regrowth sprouts (see Observations). Trees with light dieback will decline, but more slowly, the rate depending on environmental conditions; they can be expected to

TABLE 1.--Starch rating of Rio Grande cottonwood trees in various stages of decline estimated from cross sections of roots stained with I_2KI

Tree location and number[1]	Crown dieback[2]	Regrowth[3]	Starch content
PA-4	None	--	High
PA-5	None	--	Moderate
PA-6	Light	Good	Very high
HP-5	Light	Good	High
HP-6	Light	Good	High
PA-3	Light	Poor	Low
PA-2	Moderate	Good	Moderate
PA-1	Moderate	None	Moderate
HP-4	Heavy	Good	Moderate
HP-8	Heavy	Good	Moderate
HP-3	Heavy	Good	Low
HP-1	Heavy	Poor	Low
HP-2	Heavy	Poor	Very low
HP-7	Heavy	Poor	Depleted

[1] PA = Pueblo del Arroyo. From the Pueblo Bonito Bridge to Pueblo del Arroyo.
HP = Hungo Pavi. Opposite Hungo Pavi.

[2] None = No dieback.
Light = Some terminals killed, more than 75% of crown remaining.
Moderate = All terminals killed, rest of crown remaining.
Heavy = All terminals killed back to primary branches.

[3] None = No visible regrowth of damaged crowns.
Poor = Regrowth sprouts short, with small, usually off-color leaves.
Good = Regrowth sprouts long and vigorous, with large, bright-green leaves.

live another 5 to 10 years unless conditions change. Those trees without dieback will in all likelihood develop symptoms in the next 5 to 10 years, except for those which are not subject to aggradation. Mortality may accelerate with additional stresses, such as those caused by insects (defoliating insects were observed in cottonwoods in Chaco Wash) or additional frosts.

OBSERVATIONS

A number of observations were made while trees were being selected and rated, and while excavating root systems, leading us to conclusions regarding the cause of decline of cottonwoods in the Chaco Wash.

Dieback of cottonwood in the wash was not initiated by the frost of May 1980, although tree decline was certainly accelerated by the freeze. A close examination of crowns revealed that dieback could be traced back to at least 1974. On several trees that we examined, dieback had occurred for 7 or 8 consecutive years, as indicated by scars, callous formation, and dead sprouts. Branches of other trees showed evidence of 5 consecutive years of dieback.

Excavation of the root systems of several trees ranging in diameter from 8 to 20 inches revealed that the root crown and lower boles were buried in heavy clay silt which had eroded directly from the arroyo walls or was deposited by periodic floods. Cottonwoods in the wash typically grow in "stringers"; some stringers are located close enough to the arroyo wall that soil has sloughed directly onto their bases and lower boles. Other stringers are buried in a berm which typically is 1 to 2 feet above the nearby ground level. Presumably the berm was formed when the stringers slowed flood waters and allowed aggradation of waterborne silt. The silt, resembling old mortar in consistency, was often packed densely around stems and over roots and had to be chopped with a pulaski to loosen it enough to be shoveled away. We dug down 32 inches below ground level in a clump of trees containing tree PA 3 (light crown dieback, poor regrowth, low starch), and still did not expose the root collar. The extent of aggradation was confirmed by examining the vicinity of an old horse corral located in the wash. Only the top 6 to 12 inches of a few posts were still visible. The rest were completely buried.

Trees with moderate or heavy dieback typically had few, if any, adventitious roots in the upper 12 inches of soil, and only small (<0.5 inches diameter) roots above the original root collar. Most fine (nonwoody) roots were necrotic. Aggraded soil around these trees was typically fine textured and densely packed. Trees with light or no dieback usually were growing close to the streambed and were buried in loose, sandy material which was fairly shallow. Adventitious roots, as well as original lateral roots (indicated by butt swell), were present in the upper 12 inches of soil.

Regeneration from seed was not observed. Root sprouts were rare, but occurred more frequently from trees that were located near the streambed or along temporary water courses formed during high water and had their roots exposed by erosion.

Dieback initiated by the freeze of 1980, or before, has continued. Some trees had all stages of dieback, from foliage chlorosis through foliage necrosis to complete defoliation and dead. Even resprouts initiated after the 1980 freeze are dying back. Secondary, canker-causing fungi, which followed the initial dieback, were associated with the recent dieback. Although we did not precisely determine how many trees were damaged, we estimate that half of the trees in the wash may have moderate to heavy dieback.

CONCLUSIONS AND RECOMMENDATION

Burying of tree roots by flood plain aggradation has placed the cottonwoods in the wash in a stressed condition, causing a long-term gradual decline, and making them susceptible to damage by environmental factors and biotic agents. Fine roots that absorb water are dying and no regrowth is occurring in response to the dieback. Normal root elongation and therefore normal absorbtion-root formation is not occurring because of reduced aeration and physical restriction caused by compaction of silt. Death of roots without replacement severly reduces mineral and water absorbtion; reduced aeration triggers anaerobic respiration that causes rapid utilization of stored food reserves. The 1980 freeze came at time when the starch reserves, already seriously depleted by aggradation, had been farther drained in order to grow new crowns. The result was massive stem and root dieback and poor resprouting. The dieback has continued, but at an increased rate, because of the inability of most trees to build up depleted starch reserves.

The stands of trees in Chaco Wash, composed of about 10,000 cottonwoods and a few willows, will in all probability became seriously understocked in a few years and will cease to exist, except for a few, widely separated individuals, in as few as 20 years. It appears to us that the only feasible alternative to doing nothing, and thereby allowing cottonwoods to disappear from Chaco Wash, is to reestablish a program of periodic planting to replace declining trees. We recommend that the 14 cottonwoods rated and photographed in this evaluation be permanently located on aerial photographs and on the ground, and that annual estimates of crown condition be made in order to confirm our estimates of rate of decline.

LITERATURE CITED

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